GARNET-PYROXENE GROWTH IN ECLOGITE INCLUSIONS FROM THE GARNET RIDGE KIMBERLITIC DIATREME, ARIZONA.

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Petrographic studies and electron probe analyses of compositional zoning have been made to evaluate hypotheses for the origins of Garnet Ridge eclogites. The rock investigated in most detail is a sodic (8.00% Na20) garnet-poor eclogite containing clinopyroxene, garnet, phengite, rutile, lawsonite, and pyrite. Garnets and pyroxenes are primarily Py-Alm-Gross and Jd-Di-Ac solid solutions, respectively. Generalized sequences of garnet and pyroxene zoning are shown below and in Figs. 1 and 2. Phengite is unzoned with the following 7-cation formula: $K_{.94}A_{1.32}Fe_{.12}M_{.92}G_{.53.74}A_{1.26}$.

Garnet:	A1m	Gross	Py	Clinopyroxene:	Jd	Ac	Di-Hd
	69	21	10	CORE	58	12	30
	65	26	9				
discontinuity -			discontinuity	7 -			
	66	14	20		75	9	16
	60	11	29				
	61	13	26	RIM	57	8	35

More detailed electron probe traverses show that the major discontinuities in Ca-Mg zoning in garnet shown in Fig. 1 are abrupt; they occur over a maximum distance of several microns. Oscillatory Fe-Mg zoning (variations up to 6% Py) occurs on a 15 micron scale in some garnet cores. Jadeite is highest in an intermediate zone in pyroxene crystals (Figs. 2, 3). Oscillatory Di-Jd zoning is pronounced on a 10-15 micron scale with variations up to 15% Jd (Figs. 2, 3). Rim compositions vary widely within single crystals, partly as a function of the contacting phases. Phengite was a late-crystallizing phase, and pyroxene in contact with phengite has relatively jadeitepoor compositions.

Models proposed elsewhere suggest that mineral zoning in a Garnet Ridge eclogite reflects equilibrium crystallization at increasing P and T (Raheim and Green, 1975), and that these eclogites represent ocean floor subducted off the west coast of North America (Helmstaedt and Doig, 1975). Ryburn and others (1976) noted the difficulty of calculating ferrousferric ratios from probe analyses of jadeite-rich pyroxene, and the problem precludes meaningful calculations of temperature based on gt-cpx Kd's for the data presented here. An analysis of error propagation in calculation of ferric iron, together with an assumption of a 1% relative error in electron probe data, can be used to calculate uncertainties in derived temperatures. Such error analysis indicates that the core and rim temperatures calculated by Ryburn and others (1976) for pyroxene and garnet in a Garnet Ridge eclogite are well within an uncertainty interval of two

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standard deviations. No pressure differences between core and rim crystallization may be inferred from available data.

Textures indicate that some garnets in many of the eclogites began growth as hollow, skeletal crystals which subsequently filled. The textures and oscillatory zoning are unusual for metamorphic rocks, and they suggest a model of disequilibrium crystallization after overstepping of reaction boundaries. Such crystallization might be a consequence of garnet-pyroxene growth during cooling at constant pressure in the lower crust or uppermost mantle with the low geothermal gradient typical of some shield areas. Eclogite inclusions are associated with hydrated peridotite inclusions at Garnet Ridge; some of the hydrated peridotite inclusions in a similar kimberlitic diatreme, Green Knobs, are very low in sodium (Smith, this volume), and peridotite may have released sodium to recrystallizing eclogites as hydration occurred. The results here do not preclude other origins for the eclogites, such as subduction zone metamorphism. Textures and mineral zoning do indicate the probable importance of disequilibrium crystallization.

References

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Ryburn, R. J., Raheim, A., and Green, D. H., 1976, Determination of the P, T paths of natural eclogites during metamorphism--record of subduction. A correction to a paper by Raheim and Green (1975). Lithos, v. 9, p. 161-164.

Figures (next page)

Figure 1: Results of an electron probe traverse across a typical zoned garnet crystal. Points are at 10-micron intervals.

Figure 2: Results of an electron probe traverse across the center of a zoned pyroxene crystal. Points are at 10-micron intervals. The asymmetrical zoning is typical. Note the high jadeite content in intermediate zones.

Figure 3: Results of an electron probe traverse from rim to core of a different part of the same pyroxene crystal as that of Fig. 2. Points are at 3-micron intervals. Note the oscillatory jadeite-diopside zoning. Oscillations appear to follow growth boundaries and do not reflect exsolution.



Figure explanations on previous page.



315